Public health

Threat of a biological terrorist attack on the US food supply: the CDC perspective

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Deliberate contamination of food with biological agents has already been perpetrated in the USA. The US food supply is increasingly characterised by centralised production and wide distribution of products. Deliberate contamination of a commercial food product could cause an outbreak of disease, with many illnesses dispersed over wide geographical areas. Dependent on the biological agent and contaminated food, such an outbreak could either present as a slow, diffuse, and initially unremarkable increase in sporadic cases, or as an explosive epidemic suddenly producing many illnesses. Preparedness for a bioterrorist event affecting the food supply, therefore, entails augmentation of the traditional public-health infrastructure to enhance disease surveillance, accelerate capacity of laboratory detection, rapidly investigate and control outbreaks, and develop capacity for response to mass-casualty disasters.

Efforts to enhance preparedness and response capacity against terrorist attacks with biological agents frequently centre on microorganisms or chemicals that are airborne and target the respiratory system. These agents and dissemination modalities were developed in military biowarfare programmes with the objective to produce the greatest number of battlefield casualties as rapidly as possible by the most efficient delivery method.[1] Biological attack on the food supply was not regarded as a primary strategy in military biowarfare programmes.

The objectives of terrorists, however, can differ from those of military strategists. Terrorists might target the civilian population to create panic and threaten civil order. As mailings of envelopes containing *Bacillus anthracis* in the USA have shown, limited dissemination of biological agents by simple means, causing few illnesses, can produce considerable public anxiety and challenge the public-health system.[2]

Intentional contamination of food has already happened in the USA. In September, 1984, members of a religious cult contaminated salad bars in The Dalles, Oregon, with *Salmonella typhimurium*; 751 people developed salmonellosis. This attack was reportedly a trial run for a more extensive attack that was planned to disrupt local elections later that year.[3] The cult was also in possession of strains of *Salmonella typhi*, the causative organism of typhoid fever, which is a more severe and invasive illness than non-typhoidal salmonellosis. Had the cult used *S typhi* in a larger subsequent attack, morbidity might have been higher. In 1996, a reference strain of *Shigella dysenteriae* type 2 was used by a laboratory worker to deliberately infect colleagues with contaminated food.[4] In 1970, a postgraduate student in parasitology at an agricultural institute near Montreal, Canada, deliberately contaminated food consumed by his roommates with the ova of *Ascaris suum*, a large worm of pigs. The parasite caused severe disease characterised by massive pulmonary infiltrates, asthma, and eosinophilia.[5] The US General Accounting Office did a review of the preparedness of federal food safety regulatory agencies,[6] in which it stated that, "Although few actual incidents or threats of deliberate food contamination with a biological agent have occurred to date, there is little assurance that this track record will continue".

The presentation of a terrorist attack on the food supply could resemble that of an unintentional foodborne disease outbreak. In such a case, keeping the consequences to a minimum by rapid identification of contaminated food and removal of this food from circulation will depend on robust surveillance, speedy investigation of outbreaks, laboratory-diagnostic capacity, and communication between care providers, local, state, and federal public-health agencies, and the news media. Deliberate point of source contamination of a widely consumed item can produce many illnesses, needing deployment of extensive medical resources. Time is of the essence: the shorter the time from onset of illness to removal of contaminated food and other control measures, the smaller the number of affected people.

Vulnerability of the US food supply

The US food supply comprises thousands of classes of foods, domestically produced and imported. It is characterised by ever-more centralised production and processing and wide distribution of products. Unintentional foodborne disease outbreaks have arisen over large, dispersed, geographical areas, a situation that could delay recognition of the outbreak and complicate identification of the contaminated food.[7,8] Deliberate contamination of foods could produce a similar situation.

The potential results of an attack on the food supply can be inferred from examples of unintentional foodborne disease outbreaks. In 1994, an estimated 224 000 people in the USA were infected during an outbreak of *Salmonella enteritidis*, caused by contamination of pasteurised liquid ice cream that was transported in tanker trucks. National distribution of the ice cream resulted in one of the largest foodborne disease outbreaks in US history.[9] In 1996, over 7000 children in Sakai City, Japan, became ill with *Escherichia coli* O157:H7 infection from

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contaminated radish sprouts served in school lunches. The outbreak resulted in broad-reaching psychological trauma, with discrimination against residents of Sakai City, bullying of recovered paediatric patients, and suicide.[10] In 1985, over 170 000 people were infected during an outbreak of *S typhimurium* that was resistant to nine antimicrobial agents, which was caused by contamination of pasteurised milk from a dairy plant in northern Illinois.[11]

An attack on the food supply, or even the threat of such an attack, could also result in enormous financial costs. The detection of cyanide in two imported Chilean grapes resulted in an embargo of all Chilean fruits by the USA,[12] and an outbreak of *E coli* O157:H7 infection resulted in the recall of 25 million pounds of ground beef.[13]

Potential biological agents

The US Centers for Disease Control and Prevention (CDC) has prepared a strategic plan for bioterrorism preparedness and response, which includes a list of critical biological agents for public-health preparedness.[14] The highest priority category of agents includes those that are easily disseminated, cause high mortality and morbidity, can produce social disruption, and need special action for public-health preparedness. One agent that might be foodborne in this category is *Clostridium botulinum* neurotoxin. This toxin is the most lethal substance known, with an LD_{50} estimated at 0·001 μg/kg.[15] Naturally arising foodborne botulism is caused by ingestion of preformed toxin, typically in home-canned foods that have been inadequately cooked and canned. The toxin produces a flaccid paralysis that can result in death from respiratory arrest if untreated.[16] 95% of people with laboratory-confirmed botulism are admitted, and 62% of patients need mechanical ventilation;[17] a large-scale attack could therefore overwhelm medical-care facilities. In 1995, Iraq disclosed that during the Persian Gulf war it loaded 11 200 L of botulinum toxin preparation into scud missile warheads.[18] RISE, a terrorist group of the early 1970s, reportedly planned to introduce botulinum toxin into the Chicago water supply.[19] Aum Shinrikyo, the apocalyptic cult that released nerve gas on Tokyo subways in 1995, reportedly had produced stocks of botulinum toxin and other biological agents.[20] The toxin is also commercially produced for various therapeutic purposes.

B anthracis is included in the CDC list of highest priority agents for its potential as an agent that can be dispersed by aerosol. Foodborne anthrax is a rare but naturally occurring disease in regions of the developing world, where local custom favours consumption of raw or undercooked meat, and an absence of veterinary-health and food-safety programmes results in the slaughter and consumption of animals infected with anthrax. Foodborne anthrax presents in two forms: oropharyngeal anthrax, a distinctive syndrome with low mortality; and intestinal anthrax, which presents as an acute abdomen-like syndrome.[21] The rarity of this disease suggests that the infectious dose is high and that thorough cooking of food effectively reduces the levels of contamination encountered in naturally contaminated meat. The applicability of these observations to scenarios of deliberate contamination of food with *B anthracis* is not known.

The category of second most important biological agents for public-health preparedness consists of organisms that are quite easy to disseminate, cause moderate morbidity and low mortality, and need specific enhancement of diagnostic and surveillance capacities. This category includes several foodborne pathogens (panel). With proper treatment, these organisms are infrequently lethal. However, if a sudden large increase of cases overwhelmed medical resources, appropriate treatment might not be available to all victims.

Salmonella serotypes are notable for ease of propagation with simple laboratory facilities and for their ability to survive in the environment. With the exception of *S typhi*, *Salmonella* spp generally produce a self-limited, gastrointestinal syndrome with a mortality rate of 0·4%.[22] *S typhi* produces a debilitating febrile illness—typhoidal fever—with mortality rate of less than 1% in treated patients and up to 10% in untreated patients, and long-term symptom-free carriage in 3% of patients, who can spread it to others. The bioterrorism potential of *S typhi* was recognised in a 1970 WHO report,[25] which assessed a potential attack on municipal water supplies with the organism.

Shigella spp, which are frequent worldwide, cause diarrhoeal syndromes of variable severity; *Sh dysenteriae* type 1 has a low infectious dose,[26] and causes dysentery with severe complications and death rates of up to 20% in admitted patients without appropriate treatment.[24] *Sh dysenteriae* is rare in the USA, but most clinical laboratories have reference strains.

E coli O157:H7 causes bloody diarrhoea and abdominal cramps; it is the most common cause of the haemolytic-uraemic syndrome in children in the USA.[28,30] This syndrome arises in 5% of patients infected with *E coli* O157:H7; about 35% of these have late complications, and 3% of those die.[28] The organism has a low infectious dose and is therefore highly transmissible,[27] and reference strains are kept by clinical laboratories.

Vibrio cholerae O1 produces large-scale outbreaks of dehydrating diarrhoea in the developing world.[28] With appropriate treatment, mortality is very low; however, widespread disease could overwhelm unprepared medical-care facilities, and cases of severe untreated cholera have mortality rates that can reach 50%.[31] Both cultures and purified cholera toxin are available commercially for research purposes.

Beyond this list are various foodborne pathogens that could potentially be used, including viral and parasitic agents such as hepatitis A and *Cryptosporidium*.

Agencies with a role in foodborne disease events

In the USA, the main agencies involved in detection and epidemiological investigation of foodborne disease outbreaks—unintentional or intentional—include local and state health epidemiology departments, public-health laboratories at the local and state level, the Council of State and Territorial Epidemiologists, the Association of Public Health Laboratories, and the CDC. Agencies that have regulatory authority over foods include state departments of agriculture or food-safety divisions, and the federal food-safety regulatory agencies, mainly the US Food and Drugs Administration (FDA) and the US Department of Agriculture (USDA). Both state and federal agencies have inspection powers over the food manufacturers and processors they regulate, and can require hazard analysis to identify important points for risk of contamination. Both state and federal regulatory agencies participate in food-specific aspects of outbreak investigation, especially related to tracking of suspected foods and their recall. A trace-back investigation locates the origin of the food vehicle to establish the source of contamination, often by review of the records of vendors, shippers, producers, and processors, and by inspection of their facilities. Integration of data from the

Leading foodborne biological terror agents and selected characteristics

Agent	Availability	Minimum infectious dose, secondary transmission	Clinical syndrome	Case-fatality	Other characteristics of microbe or illness
Botulinum toxin	Organism ubiquitous in environment; cultures need anaerobic conditions	LD_{50}=0·001 μg/kg[14]	Descending paralysis, respiratory compromise	5% (treated)[16]	95% of patients need hospitalisation; 60% of patients need intubation
Salmonella serotypes (excluding *Salmonella typhi*)	Clinical and research laboratories, culture collections, poultry, environmental sources	10^3 organisms[22] Limited secondary transmission	Acute diarrhoeal illness, 1–3% chronic sequelae	>1%[23]	Organism hardy, lengthened survival in the environment
Salmonella typhi	Clinical and research laboratories	10^5 organisms[22] Secondary transmission possible	Acute febrile illness, protracted recovery, 10% relapse, 1% intestinal rupture	10% untreated, 1% treated[23]	Clinical syndrome unfamiliar in the USA; long incubation period (1–3 weeks); produces asymptomatic carrier rate in 3% of cases
Shigella spp	Clinical and research laboratories	10^2 organisms[25] Secondary transmission possible	Acute diarrhoea, often bloody	For most common species in US, <1%[23]	
Shigella dysenteriae type 1	Clinical and research laboratories	10–100 organisms[24] Secondary transmission possible	Dysentery, seizures	Up to 20% (treated)[22]	Causes dysentery, toxic megacolon, haemolytic-uraemic syndrome, convulsions in children
Escherichia coli O157:H7	Clinical and research laboratories, bovine sources, farms	>50 organisms[26] Secondary transmission possible	Acute bloody diarrhoea, 5% HUS, longer-term complications	1%[27]	Long-term sequelae: hypertension, stroke, renal insufficiency/failure, neurological complications[27,28]
Vibrio cholerae	Clinical and research laboratories	10^8 organisms[29] Secondary transmission possible	Acute life-threatening dehydrating diarrhoea	Up to 50% untreated 1% treated[29]	Historically, causes massive waterborne epidemics in areas with poor sanitation

HUS=haemolytic-uraemic syndrome.

epidemiological and trace-back investigations is crucial to properly identify the contaminated food and the mode of contamination, underscoring the need for the closest collaboration between epidemiologists, microbiologists, and food-safety officials.

In cases of suspected bioterrorism associated with the food supply, the Federal Bureau of Investigations assumes leadership of the investigation, with the possible participation of other law-enforcement agencies. The legal basis to governance of investigations related to bioterrorism has been described.[32] An important concern of the Federal Bureau of Investigations in such enquiries is collection of evidence of forensic standards, essential for identification of perpetrators and for criminal prosecution, with which epidemiologists might not be familiar. Of concern to epidemiologists is the great need for rapid sharing of intelligence information that could provide vital clues to the epidemiological investigation. Both groups of people must be satisfied to assure that sources of infection are rapidly identified and controlled, and that perpetrators are identified and captured—the ultimate prevention measure in addressing bioterrorism.

Detection of an attack

Contamination of food with biological agents by terrorists can be recognised because a threat is made—ie, it is an overt attack—or, if disseminated covertly, by epidemiological investigation of an outbreak. Response to an explicit threat of a biological attack on food will entail assessment of the credibility of the threat by law-enforcement and intelligence agencies. Protocols for assessment have been developed for some types of threats by terrorists,[33] and these need to be formalised for threats to food as well.

In the case of a covert attack, the event will be detected and investigated initially as an unintentional foodborne disease outbreak. As with any foodborne outbreak, early recognition and investigation is vital if the food vehicle has wide distribution, and prevention of additional cases may depend on identification and recall of the yet unconsumed food product. Additionally, prompt suspicion that the attack is by terrorists will help direct the criminal investigation by law-enforcement authorities and bring into play the full array of federal resources available to counter bioterroristic attacks.[6]

The adequacy of response will depend on the capacity of public-health officials to respond to all foodborne disease outbreaks. Hence, a cornerstone of preparedness is improvement of the public-health infrastructure for detection and response to unintentional outbreaks: ensuring robust surveillance, improving laboratory diagnostic capacity, increasing trained staff for rapid epidemiological investigations, and enhancing effective communications. Preparedness for such a situation also requires the capacity to respond to extraordinary demands on emergency services and medical resources.

Surveillance

Detection of outbreaks of foodborne diseases depends on the ability of clinicians and public-health officials to recognise clusters of illness. When an outbreak results in a dense pattern of illness, in which several affected patients present to the same care facility, the outbreak could be detected by clinicians, by observation of a specific clinical syndrome. When people affected by outbreaks are dispersed geographically—eg, in outbreaks caused by low-level, intermittently contaminated foods, leading to low attack rates—the outbreak might not be recognised until reports of notifiable diseases are analysed at the state or national level.[8] Reporting of foodborne disease outbreaks has been accelerated by introduction of the national electronic foodborne disease outbreak reporting system, a web-based system for states to report such outbreaks to CDC.

Surveillance of many foodborne diseases has relied mainly on passive laboratory-based observation, whereby clinicians or laboratories report cases of notifiable diseases or send isolates to state health departments, who in turn report the cases to CDC. These processes are the backbone onto which new systems—that offer more timely transmission of information—have been grafted. They improve the likelihood of detection of an outbreak caused by putative bioterrorist attack on the food supply. The systems, described below, are complementary, each focusing on a specific aspect of surveillance.

CDC maintains intensive surveillance for cases of botulism in collaboration with state health departments. When a clinician suspects a diagnosis of botulism and seeks botulinum antitoxin treatment, he or she notifies the state department of health. CDC epidemiologists are available 24 h to provide clinical consultation on cases, arrange for testing of clinical and food specimens either at the state public health laboratory or at CDC, and when the diagnosis seems probable, release botulism antitoxin for treatment of patients. The states of Alaska and California have their own clinical consultative services and maintain antitoxin stocks. Antitoxin for treatment of foodborne botulism is not available from any other sources in the USA.[34] One case of botulism is routinely treated as a public-health emergency. State and local public-health departments do an immediate epidemiological investigation to identify and treat additional patients, identify the contaminated food, and work with state and federal food-safety regulatory agencies to eliminate the food vehicle by seizure or recall.[34]

PulseNet is a network of public health and regulatory laboratories that do molecular subtyping of certain foodborne pathogens. Pulsed-field gel electrophoresis is the method currently used in these laboratories to generate a unique DNA pattern (genetic fingerprint) for foodborne pathogens obtained from clinical specimens or food products. These patterns are transmitted electronically to other laboratories in the network and to a regional and national electronic database of patterns. Detection of strains with indistinguishable patterns—suggesting a common source—alerts the public-health system to the possibility that geographically dispersed cases could be part of one outbreak. This alert allows investigators to focus on patients infected by strains with the same pattern.[35,36] Pulsed-field gel electrophoresis subtyping of bacterial isolates obtained from suspected foods, and comparison with patients' isolates, helps confirm the relation between food vehicle and human illness. Currently, all 50 US state public-health laboratories participate in PulseNet, as do public-health laboratories in Canada.

The salmonella outbreak detection algorithm is designed to detect increases in salmonella serotypes reported to CDC. Salmonella isolates are serotyped in nearly all state public-health laboratories, and the results are transmitted to CDC electronically by a computer-based electronic reporting and analysis system—the Public Health Laboratory Information System.[37] The algorithm is computerised, and compares the count per week of each salmonella serotype in the database of this system with summary historical data by state or region;[38] increases over the expected number of isolates for each serotype are reported to state epidemiologists. This system has helped to identify several large, diffuse multistate outbreaks caused by various salmonella serotypes,[39,40] and is now routinely used at the state and federal level.

FoodNet, the foodborne disease component of the CDC, FDA, and USDA Emerging Infection Programme,[22] was established to ascertain the burden of foodborne illness, with population-based active surveillance and related studies. FoodNet sites do population-based active surveillance for laboratory-diagnosed cases of ten enteric bacterial and parasitic infections and for haemolytic-uraemic syndrome.[22] Other pathogens and syndromes will be added to FoodNet in the future. In 2000, the states of Oregon, Minnesota, Georgia, and Connecticut, and selected counties in California, New York City, Tennessee, Colorado, and Maryland, with a total population of over 30 million people, were included in FoodNet catchment areas.[22] Continuing data collection permits rapid detection and investigation of increases in rate of the diseases under surveillance.

Diagnosis and characterisation of foodborne biological agents

Rapid diagnosis of causative agents during the investigation of unexplained foodborne disease outbreaks depends partly on the readiness with which disease clusters are recognised by clinicians and local and state public-health departments. A key factor in agent identification is ordering of the appropriate diagnostic laboratory test; thus clinicians must be familiar with the probable agents and their clinical presentations, ordering tests must not be hampered by their cost concerns, and they must know how to contact consultants in the public-health sector when needed.

Most foodborne pathogens on CDC's strategic plan for bioterrorism preparedness and response[14] are detectable by routine culture in state public-health laboratories. Botulism is diagnosed in some state laboratories and at CDC. CDC has developed a National Laboratory Response Network for bioterrorism—specialising in diagnosis of biological agents—that includes commercial, veterinary, and public-health laboratories. This network provides standardised protocols for diagnosis and reagents, makes initial, rapid diagnoses, and then refers specimens to appropriate specialty laboratories at CDC and elsewhere.

Recognition of an attack and response

Recognition

A foodborne disease outbreak—deliberate or unintentional—might first be recognised by astute members of the public, clinicians, or clinical laboratory workers who might report a cluster of cases with similar clinical presentation or microbiological diagnosis suggesting a common source, or by public-health officials who might note an increase in reported cases.

Initially, whether a foodborne disease outbreak is intentional or unintentional might not be apparent. We should remember that many hundreds of unintentional foodborne outbreaks are reported every year. Epidemiological clues to a deliberate, covert act of contamination are unusual relations between individual, time, and place of the outbreak, or unusual pathogens or food vehicles. However, features suggestive of deliberate contamination might arise in unintentional outbreaks as well. Conversely, these epidemiological clues might not necessarily be evident in an outbreak due to deliberate contamination.

Epidemiological features alone cannot prove an act of terror; rather, they inform the investigators, and might prompt consultation with law-enforcement agencies, which can confirm or refute the possibility of malicious contamination. In the case of the cult contamination of salad bars in Oregon, the attack was a trial run for a subsequent larger attempt planned to interrupt local elections a month later, so no claim of responsibility was made and no motive was obvious. Public-health officials considered the possibility of deliberate contamination and consulted law-enforcement agencies early in the investigation. Bioterrorism was rejected as the cause because specific evidence was not uncovered by local and federal law-enforcement agencies.[3] Nevertheless, the epidemiological investigation did serve to protect the public, since the terrorists' target—salad bars—was correctly identified as the exposure of risk, and these were closed. This closure, and the investigative activities of law enforcement, seemed to have deterred the cult from attempting a subsequent attack. Later, testimony of witnesses and discovery of a clandestine microbiology laboratory in the cult's compound revealed the true nature of the outbreak.

Response

The public-health response to a terrorist event aimed at the food supply consists of two components. One is the epidemiological investigation to identify the agent and contaminated food and implement control measures. Public-health agencies and their counterparts in food-safety regulatory agencies address these tasks routinely in response to naturally arising foodborne disease outbreaks. The second component is the medical response to casualties. Dependant on the biological agent and number of casualties, medical supplies and personnel might need to be transported rapidly to the outbreak site; alternatively, large numbers of patients might need to be evacuated. The complexity of the logistics involved needs integrated action by local, state, and federal agencies.

The objectives of the epidemiological investigation of an outbreak of foodborne disease would not greatly change if intentional contamination is suspected. Identification of the causative agent, vehicle of transmission, and manner of contamination remain the most important aspects of an investigation, followed by timely implementation of control measures, including removal of the contaminated food from circulation and proper treatment of exposed people.

Although local and state authorities will do most investigations, CDC can offer assistance with public-health assessment, identification of agents, and investigation of the outbreak when it is especially large, severe, or unexplained. CDC's Epidemic Intelligence Service is a 2-year training programme in investigative epidemiology, including bioterrorism response. Epidemic intelligence officers are on call and can be dispatched immediately, if necessary, as part of a larger CDC rapid-response team. Support from CDC field-teams and headquarters includes subject-matter experts on specific disease areas and outbreak investigation. CDC would also help to coordinate multistate investigation activities, including: formulation of case definitions; case finding; pooling and evaluation of data on potential exposures in different geographical locations; rapid development of standardised instruments; implementation of case-control studies to identify specific food vehicles; collection of laboratory samples; transport and processing; collating information from trace-back investigations; coordination with law enforcement, food-safety regulatory agencies, and agencies involved in emergency medical response; and standardisation of treatment and prophylaxis recommendations.

Resources and protocols for the medical response component, needing rapid transport of medical supplies and personnel or patients' evacuation, are part of overall bioterrorism-response preparedness, and have been described elsewhere.[41] Adequate stocks of antimicrobial drugs, antitoxins, other medications, and ventilators and other medical equipment are maintained in stockpiles, and reserves of medical personnel must be available for immediate deployment to casualty locations. CDC possesses a national pharmaceutical stockpile to assure the availability of pharmaceuticals and medical equipment in case of a bioterrorist event. The deployment of ventilators, the location of intensive-care-unit beds nationwide, and the logistics of patients' evacuation are being addressed by the national disaster medical system. A biological terror attack that targets a food distributed over a wide geographical area could challenge the assurance of adequate medical supplies and personnel in far-flung locations. The effectiveness of the medical response will depend on timely epidemiological surveillance data obtained by state health departments and the CDC to direct the medical resources to the casualties in their care. Of particular note are situations concerning many patients who need ventilatory support, such as those with botulism. Bulky delicate ventilators are difficult to transport to scattered locations; in some circumstances, patients' evacuation is desirable. Preparedness includes equipment and personnel to provide temporary manual ventilatory support to patients with ventilatory compromise.

Overall responsibility for the federal response in a national disaster situation would rest with the Federal Emergency Management Agency, and state emergency management authorities would have a key role. Dependent on the magnitude of the outbreak, logistic support of the medical response might be provided by the department of defence and other federal agencies.

Communications

Swift communication between health-care providers, public-health officials at various levels, and government agencies is an absolute requirement for a rapid, effective response to a bioterrorist attack on the food supply. Communication patterns similar to those used in coordination of multistate outbreak investigations will probably be effective for incidents of intentional contamination of food and be tested in simulated exercises.

Clinicians, clinical laboratory staff, and coroners who identify suspected cases or clusters of illness must have lists of appropriate local contacts so they can notify the public-health sector of their findings. Local health departments, upon notification by clinicians or detection of suspicious findings from surveillance data, should notify state public-health departments, even as they begin their investigation locally.

CDC has 24-h capacity to respond to telephone reports of a foodborne disease emergency from state health departments. CDC can contact all state epidemiologists and directors of state public-health laboratories electronically and by fax about ongoing surveillance issues and outbreaks, and it maintains updated lists of emergency telephone contacts for state departments of health and internet communication networks. These modalities are used routinely to inform public-health officials of ongoing outbreaks and to coordinate multistate investigations. In the case of intentional contamination of food, these communication systems would function as they do in regular outbreaks. The *Morbidity and Mortality Weekly Report*, a publication widely read by public-health professionals, serves to disseminate information quickly from CDC to the public-health community and the media.[42]

CDC collaborates closely and routinely with federal food-regulatory agencies, the FDA, and the USDA on trace-back investigations of contaminated foods implicated in many of the thousands of foodborne disease outbreaks reported yearly in the USA. Dependent on the food that is affected, the FDA or USDA's regulatory authorities would be engaged rapidly during a bioterrorist event linked to food. Liaison personnel from these agencies work at CDC and are familiar with the centre's investigative routines and emergency protocols. Liaison workers from the CDC are stationed at these regulatory agencies, and they provide continuing communications between the agencies.

CDC, with the FDA, the USDA, and state regulatory agencies, seeks open rapid communication with industries implicated in any foodborne outbreak to obtain information related to the investigation. This communication is coordinated with the appropriate regulatory agency, which has the authority to recall a contaminated food from the market.

Web-based resources have been developed to facilitate communications between public-health officials in outbreak and other emergency situations. The Health Alert Network enhances electronic public-health infrastructure and provides internet connectivity to local health departments. Epi-X, a secure network that uses this infrastructure, is used to develop and disseminate health communications among public-health officials, and is of particular application in emergency situations needing rapid secure communication and dissemination of information.

Intense media coverage of a bioterrorist event is to be expected. Skill and experience are needed to transmit accurate information through the media about the nature and extent of the event, the suspected or implicated foods, and measures to take to prevent exposure or results of exposure. The accuracy, timeliness, and consistency of the information provided are important. CDC press officers routinely follow outbreak investigations in collaboration with state and local health departments, and can prepare accurate, balanced messages for the mass media. Extensive experience in multistate outbreaks will facilitate coordination of messages with the press offices of federal regulatory agencies and state health departments before release of information to the public. Provision of the media with regular updates on outbreak investigations will foster a sense of trust and order in transmission of information.

Preparedness

In the event of a foodborne bioterrorist alert, law-enforcement agencies lead the response. With other federal agencies, CDC has a support role, focusing on the epidemiological component. CDC identifies response leaders and defines expert teams that address the various areas of the epidemiological investigation, including surveillance, field investigation, and liaison with food-safety regulatory agencies, law-enforcement agencies, and others. CDC also lend support to the National Disaster Medical System, the Federal Emergency Management Agency, and other agencies leading the medical response. This response includes clinical aspects such as hospital services, patients' transfer, clinical support teams for intensive-care patients, mental-health services, &c.

Protocols have been developed for events connected with botulism and other foodborne agents. These protocols will include assessment of epidemiological features of an outbreak, contact lists, model case definitions and questionnaires for studies, specimen collection and shipment guidelines, summaries of clinical and pharmaceutical information, and key points for control measures to be implemented in collaboration with regulatory agencies.

Table-top and simulated exercises organised by various federal agencies have been used to test preparedness. The exercises have been used to examine the sensitivity and rapidity of detection and notification of events; to establish the adequacy of existing state and CDC resources for doing epidemiological investigations of foodborne illness in mass disaster situations; to test emergency communications between CDC and state and other federal agencies; to establish the actual time to reach contacts, collect, analyse, and disseminate data, and for the arrival of personnel and equipment; to test the adequacy of available medical resources; and to practise collaboration with non-traditional partners who would have a role in a medical disaster resulting from a biological terrorist attack on the food supply.

Conclusions

Foodborne bioterrorism, although rare, has happened in the USA and could occur again. The US food supply is characterised by centralised production and processing and widespread distribution. Realistic exercises involving the various agencies with responsibilities for bioterrorism response have proved important for increasing preparedness for foodborne bioterrorism by helping to identify necessary resources, to clarify the roles of different agencies and groups, and to further refine integrated response plans. Enhancement of recognition, response, and control of a bioterrorist attack on the food supply, and mitigation of its potentially catastrophic outcome, rest on increasing awareness in the provider community, on building robust public-health capacity to identify and investigate all outbreaks, and on preparedness to respond to events with many illnesses.

Contributors
All authors wrote the report and have seen and approved the final version.

Conflict of interest statement
None declared.

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